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Cryogenic Propulsion Stage (CPS) Configuration in Support of NASA's Multiple Design Reference Missions (DRMs)

Dale Thomas, Ph.D., Associate Center Director, Technical
NASA Marshall Space Flight Center, AL

space launch system

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NASA's Capability Driven Framework

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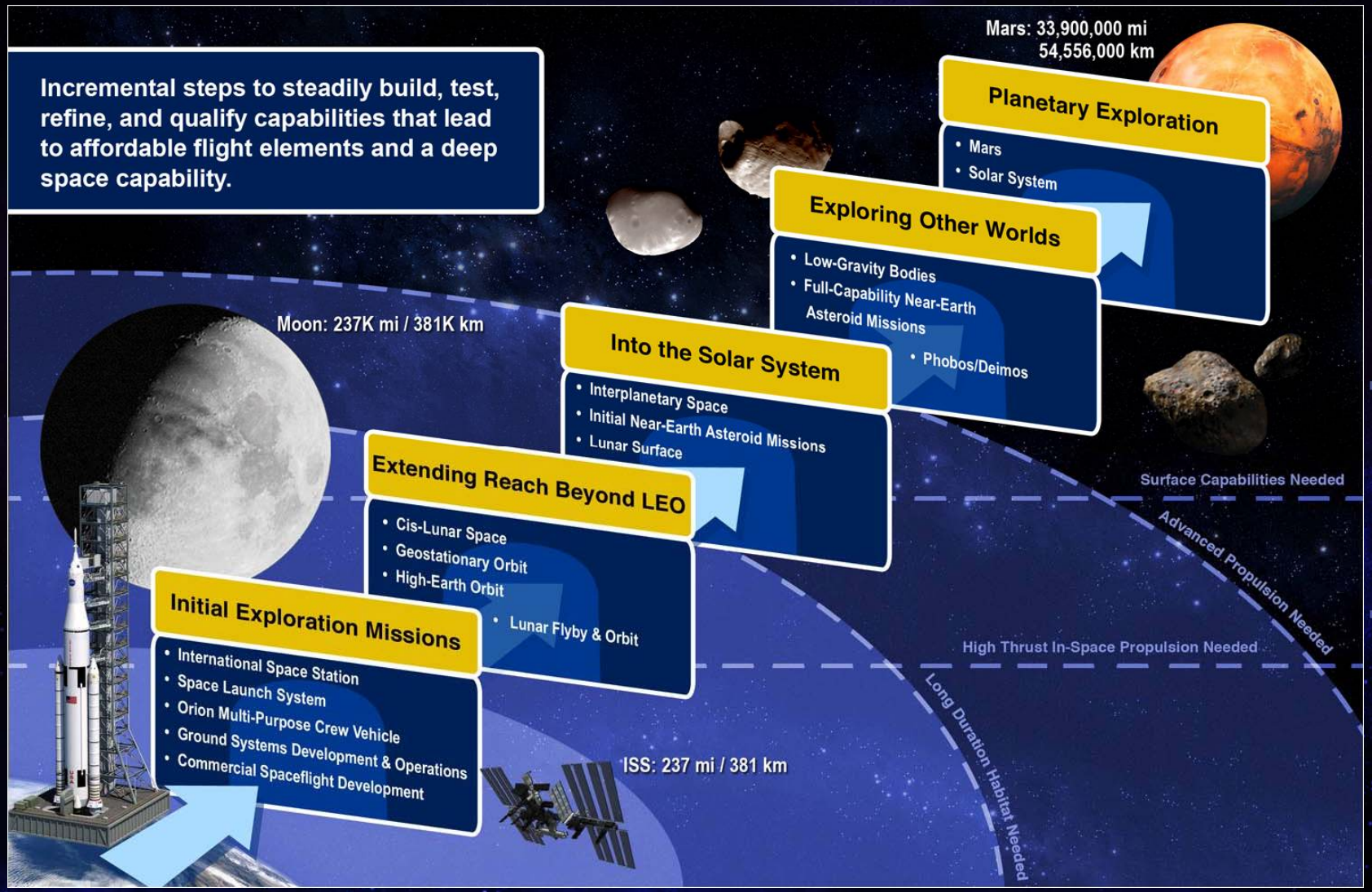

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Space Launch System (SLS)

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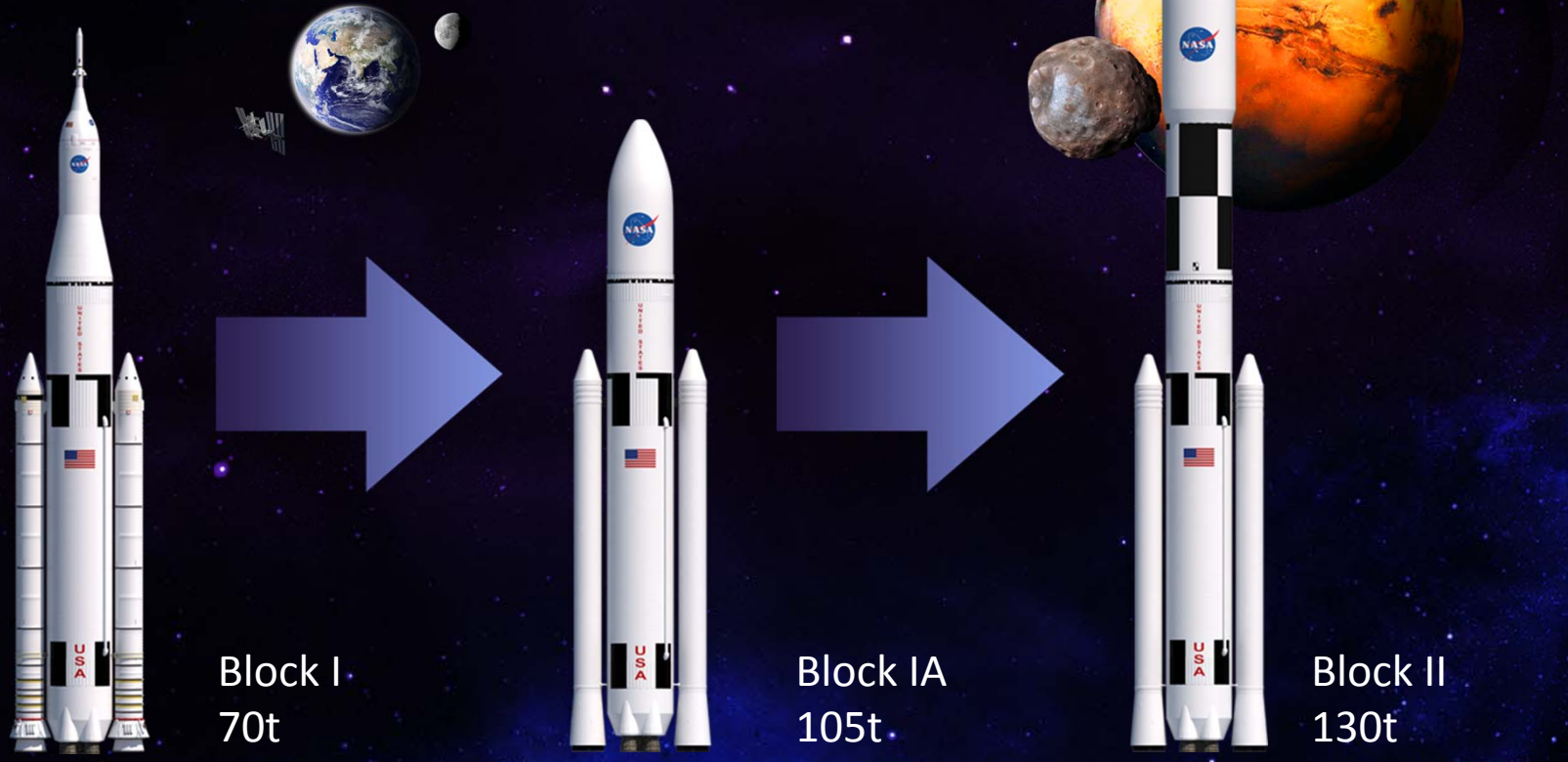
- This heavy-lift rocket will take astronauts and high-priority science payloads beyond the moon to new destinations, such as an asteroid and Mars.
- The SLS rocket will be an asset for international cooperation and help create opportunities to enrich the future for people around the world.



Block I
70t

Block IA
105t

Block II
130t

Vehicle Configuration

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SLS Cryogenic Propulsion Stage (CPS)

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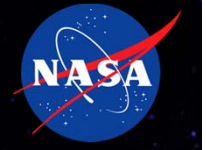

- **CPS is an in-space propulsive stage based on state of the practice design for launch vehicle upper stages**
  - **However, unlike conventional propulsive stages, it also contains MMOD, power generation and thermal control systems to limit the loss of liquid hydrogen and oxygen due to boil-off during extended in-space storage**
- **CPS provides ΔV for rapid transfer of in-space elements to their destinations or staging points beyond LEO**

Main Engine	Total Thrust: 60,000 pounds of force (lbf) Specific impulse (I_{sp}): 465 seconds Restarts: Up to 5
Total Mass	100 t or less
LEO Loiter Time	6 hr to 1 year
Circularize Capability	Responsible for circularizing itself and payloads from the SLS insertion orbit (-87 x 241 kilometers (km)) to a LEO orbit (407 x 407 km)
Attitude Control	Provides attitude control for itself and payloads during mission event where CPS is actively thrusting
Automated Rendezvous and Docking (AR&D)	Provides maneuver propellants and equipment for AR&D, both active & passive

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SLS Cryogenic Propulsion Stage (CPS)

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- **CPS is designed around a block upgrade strategy to provide affordability & maximum mission/architecture flexibility**
  - **Block 1 CPS: Short duration flight times (hours), passive cryogenic fluid management**
  - **Block 2 CPS: Long duration flight times (days/ weeks/ months), active and passive cryogenic fluid management**
- **Early SLS test flights will utilize an interim CPS (ICPS) based on commercial upper stages to enable early affordable SLS BEO missions**

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SLS CPS Concept of Operations & Functions

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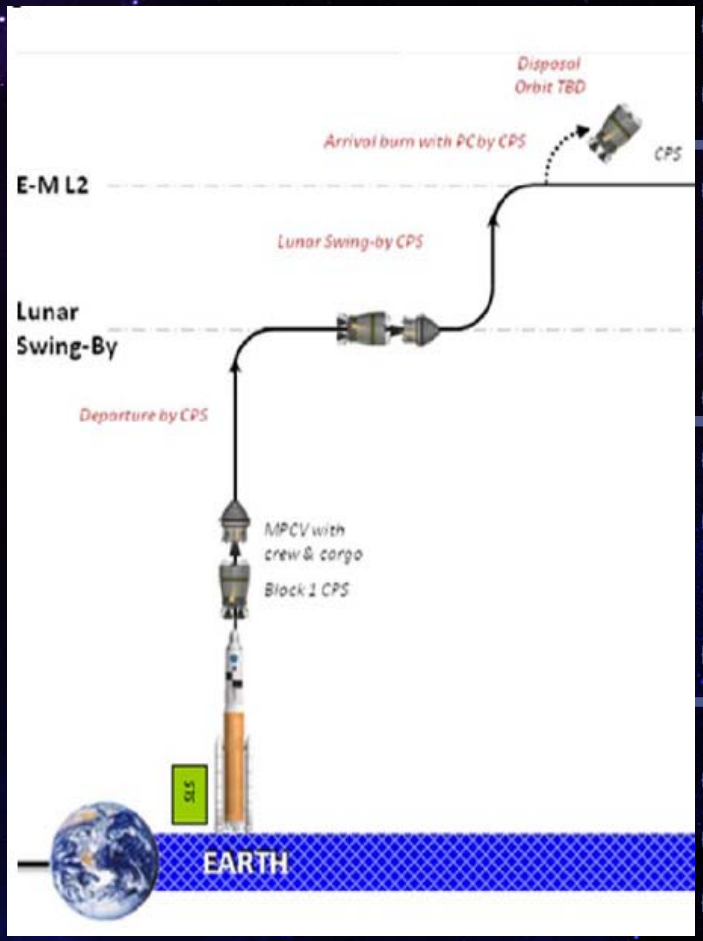
- **CPS allows expansion to multiple missions and destinations such as Near Earth Asteroids (NEA), Mars, Earth –Moon L1/L2 Lagrange points.**
- **Sustainment Functions:**
  - **Vehicle management, power, MMOD protection, propulsion, hazardous gas control, thermal management, and guidance, navigation and control (GN&C)**
- **Mission Performance Goals:**
  - **On pad, launch, seperation, circularization, loiter, deployment, transit, operation, transit & disposal**



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Summary and Technical Status

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SLS CPS provides opportunities for Partnership and Collaboration while providing significant Beyond Earth Orbit (BEO) capability for exploration.

- Safe = Higher Payload Margins
- Affordable = Less Complex Mechanisms
- Sustainable = Significantly Faster Trip Times
- Volume = Fewer Deployments and On-Orbit Operations

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